ÖGH Herpetozoa
Austrian Herpetological Society

Herpetozoa ##: 1–@ (2024)
DOI 10.3897/herpetozoa.@.e112093

An updated checklist of the amphibians and reptiles of Nayarit, Mexico with conservation status and comparison with adjoining States

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Academic editor: Bibiana Rojas ♦ **Received** 3 September 2023 ♦ **Accepted** 24 January 2024 ♦ **Published** @ ##### 2024

Abstract

Herein, we present an updated list of the species of amphibians and reptiles that inhabit Nayarit, Mexico. In the years since the publication of a previous list in 2016, threats to amphibians and reptiles in Nayarit have continued unabated and efforts to more fully catalogue the richness of Nayarit's herpetofauna have continued. Nayarit harbours 162 native species of amphibians and reptiles, representing 35 families and 85 genera. These include 37 species of amphibians (35 anurans and two salamanders) and 125 species of reptiles (one crocodile, 44 lizards, 69 snakes and 11 turtles). Of the amphibian and reptile species in Nayarit, 102 are endemic to Mexico and two endemic to Nayarit. The ecoregion with the highest richness of amphibians and reptiles in Nayarit is the Trans-Mexican Volcanic Belt followed closely by the Sierra Madre Occidental and then the Sierra Madre del Sur, the Pacific Lowlands and the Nayarit Islands. Just 5.8% of the species of amphibians and reptiles in Nayarit is IUCN-listed as Vulnerable, Endangered or Critically Endangered, 11.1% are placed in a protected category by SEMARNAT and nearly a third are categorised as high risk by the Environmental Vulnerability Score. The herpetofauna of Nayarit overlaps the most with Jalisco (88.9%). One of the main conclusions of our updated list of the amphibian and reptile species of Nayarit is that our understanding of the full complement of species is not complete, especially the reptiles.

Key Words

ecoregions, endemic species, Environmental Vulnerability Score, herpetofauna, IUCN, species status

Introduction

Woolrich-Piña et al. (2016) published a then up-to-date checklist of the amphibians and reptiles of Nayarit, Mexico, including assessments of the conservation status and threats for these taxa. In the years since that publication, several economic and social factors have changed in the State of Nayarit. In particular, several of the threats to amphibians and reptiles in Nayarit identified by Woolrich-Piña et al. (2016) have continued or even increased in extent since they published their checklist. Agricultural land cover in parts of Nayarit increased from 39% to 50% from 1999 to 2019 (Luja et al. 2022; see also Navidad Murrieta et al. (2023)). Additional continuing threats include agricultural practices, such as water consumption for irrigation and the runoff of fertilisers and

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pesticides (Loc-Barragán 2016; Ahumada Nájera et al. 2020; Loc-Barragán et al. 2020); urban expansion in the Municipality of Tepic in the Trans-Mexican Volcanic Belt (Avalos Jiménez et al. 2018, 2022) and Compostela in the Sierra Madre del Sur; tourist developments in Bahia de Bandera in Sierra Madre del Sur; highway and road construction in Jala, Sierra Madre del Sur and Huajicori in the Sierra Madre Occidental; construction of dams in the Municipality of Ruiz in the Sierra Madre Occidental (see Hernández-Guzmán et al. (2019) for a discussion of potential hydrologic impacts); and resource extraction in Huajicori in the Sierra Madre Occidental. In addition, five physiographic provinces are now recognised in Nayarit: Sierra Madre Occidental (SMO), Trans-Mexican Volcanic Belt (TMVB), Sierra Madre del Sur (SMS), Pacific Lowlands (PL) and Mexican Pacific Island System (MPIS) (Figs 1, 2) (Morán-Zenteno et al. 2018; Morrone 2019) rather than the four provinces used by Woolrich-Piña et al. (2016), so the species lists for the physiographic province need to be updated. There have also been several taxonomic updates, new records for the State and descriptions of new species (Duellman et al. 2016; Hansen and Salmon 2017; Campbell et al. 2018; Ramírez-Reyes and Flores-Villela 2018; Jadin et al. 2020; Loc-Barragán et al. 2020; McCraine et al. 2020; Reyes-Velasco et al. 2020; Wallach 2020; Ramírez-Reyes et al. 2021; Flores-Villela et al. 2022; Pérez-Ramos and Luja Molina 2022; Frost 2023; Uetz et al. 2023), which have increased the numbers of amphibians and reptiles known from Nayarit.

Given the dynamic nature of the threats to amphibians and reptiles and the dynamic nature of our understanding of the herpetofauna of Nayarit (e.g. taxonomy, increased survey activity), we here update the list of amphibians and reptiles found in Nayarit. Additionally, we present an updated summary of the conservation status. We also examine the number of species shared with adjacent States, which was not considered in Woolrich-Piña et al. (2016). We view this effort as a way to better understand how the herpetofauna is changing (i.e. this is intended as a means of summarising the state of our improving, but incomplete, understanding of the herpetofauna of Nayarit).

Physiographic characteristics of Nayarit

According to Morán-Zendero et al. (2018) and Morrone (2019) (see also Luja et al. (2014)), Nayarit contains five physiographic provinces: Sierra Madre Occidental; Trans-Mexican Volcanic Belt; Pacific Lowlands; Sierra Madre del Sur; and the Nayarit Islands (see Figs 2, 3). This differs from Woolrich-Piña et al. (2016) who used a different categorisation of physiographic regions and recognised only three (Coastal Plain, Sierra Madre Occidental, Transvolcanic Belt) on the mainland and also included the Nayarit Islands. Here, we provide some basic information of the five physiographic provinces that we use in this updated list of the herpetofauna of Nayarit, based on information in INEGI (2018a) and Blanco y Correa et al. (2021).

The Sierra Madre Occidental Province covers 57.2% of Nayarit, including the entire eastern part of the State. In

Figure 1. Map of Mexico with the State of Nayarit highlighted in green (modified from INEGI 2018b).

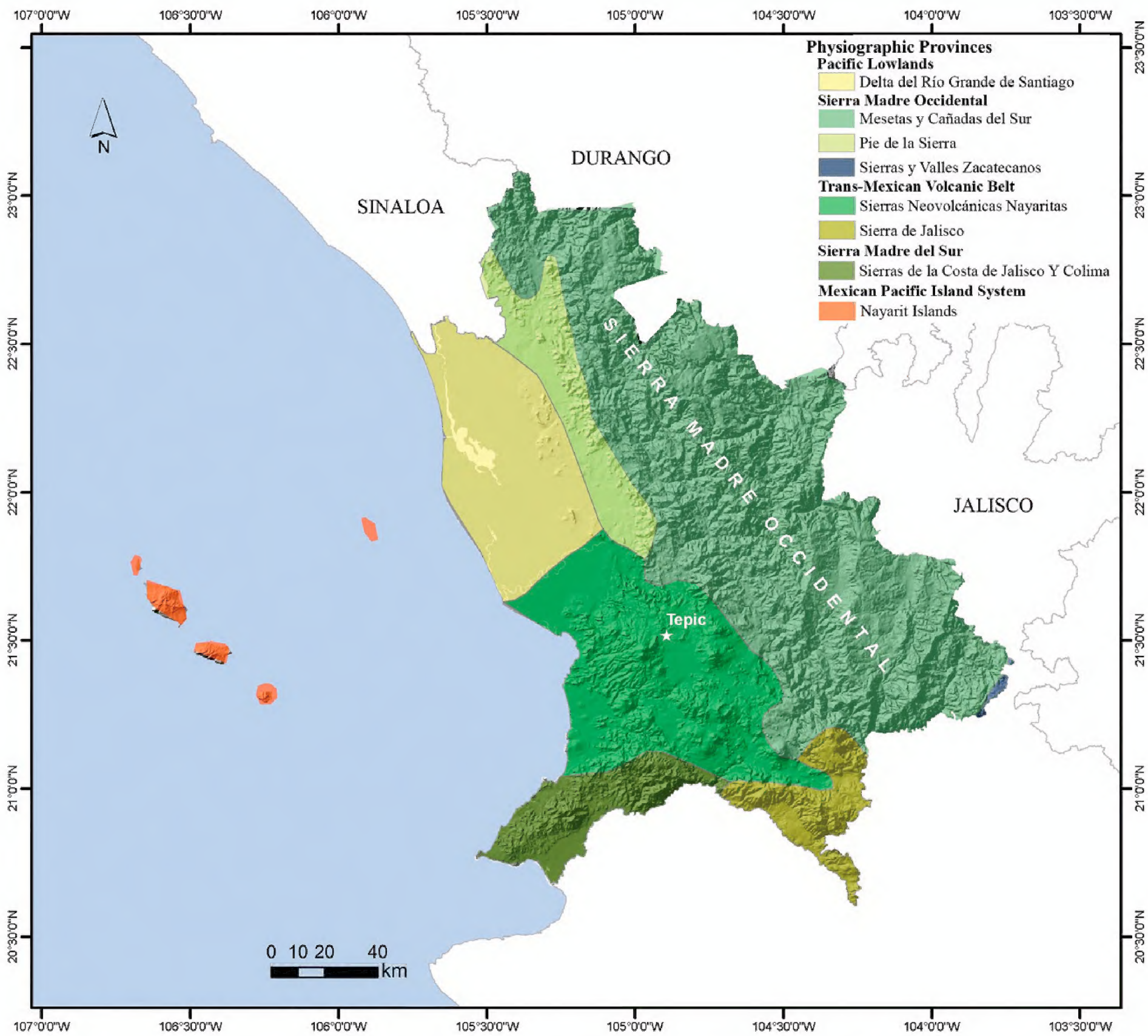

Figure 2. Physiographic provinces of the State of Nayarit, Mexico (modified from Cervantes-Zamora et al. 1990).

Nayarit, this Province being made up of three sub-provinces: Mesetas and Cañadas del Sur (50.01%); Pie de la Sierra (6.99%); and Sierras y Valles Zacatecanos (0.25%). The Trans-Mexican Volcanic Belt covers 20.03% of Nayarit, including the central portion of Nayarit from the coast to the south-eastern border of the State. In Nayarit, two sub-provinces of the Trans-Mexican Volcanic Belt are found: Sierras Neovolcánicas Nayaritas (18.34%); and Sierras de Jalisco (1.69%). The Pacific Lowlands Province encompasses 15.11% of Nayarit's territory in the north-western part of the State. In Nayarit, this Province is made up of the Delta del Río Grande de Santiago sub-province, which is an extensive plain covering the coastal area of northern Nayarit. The Sierra Madre del Sur is found in 7.61% of Nayarit in the extreme southern Nayarit. In Nayarit, it consists of the Sierras de la Costa de Jalisco and Colima sub-province. The Mexican Pacific Island System is represented in Nayarit by the Nayarit Islands sub-province, made up of the archipelagoes of Islas Marías (San Juanito, María Madre, María Magdalena and María Cleófas), Islas Marietas (Redonda, Larga, Corbeteña, Ampolla, Morro and Cuates) and Isla Isabel. These islands encompass 0.93% of the State territory and are located 115 km to the west of the San Blas coast and 10 km to the west-southwest of Punta Mita (Figs 2, 3).

Most of the State is covered by warm weather types (INEGI 2018a). The main types of this climate in the State are Warm Subhumid, present in 60.61% of Nayarit, along the coast and in the lower areas of the valleys of the Huaynamota and San Pedro Rivers, with important ramifications that extend to the east over the Sierra Madre Occidental and towards the south of the State. The Semi-warm Subhumid, present in 30.97% of the State, spreading in a strip that goes from the extreme northeast to the south of the State, including areas near Tepic and alternating with the Warm Subhumid in parts of medium altitude of the Sierra Madre Occidental. Another type of climate present in Nayarit is the Temperate Subhumid, covering only 6.16% of the State, restricted to small, very localised areas, scattered in the upper parts of the mountains. Semi-arid cli-

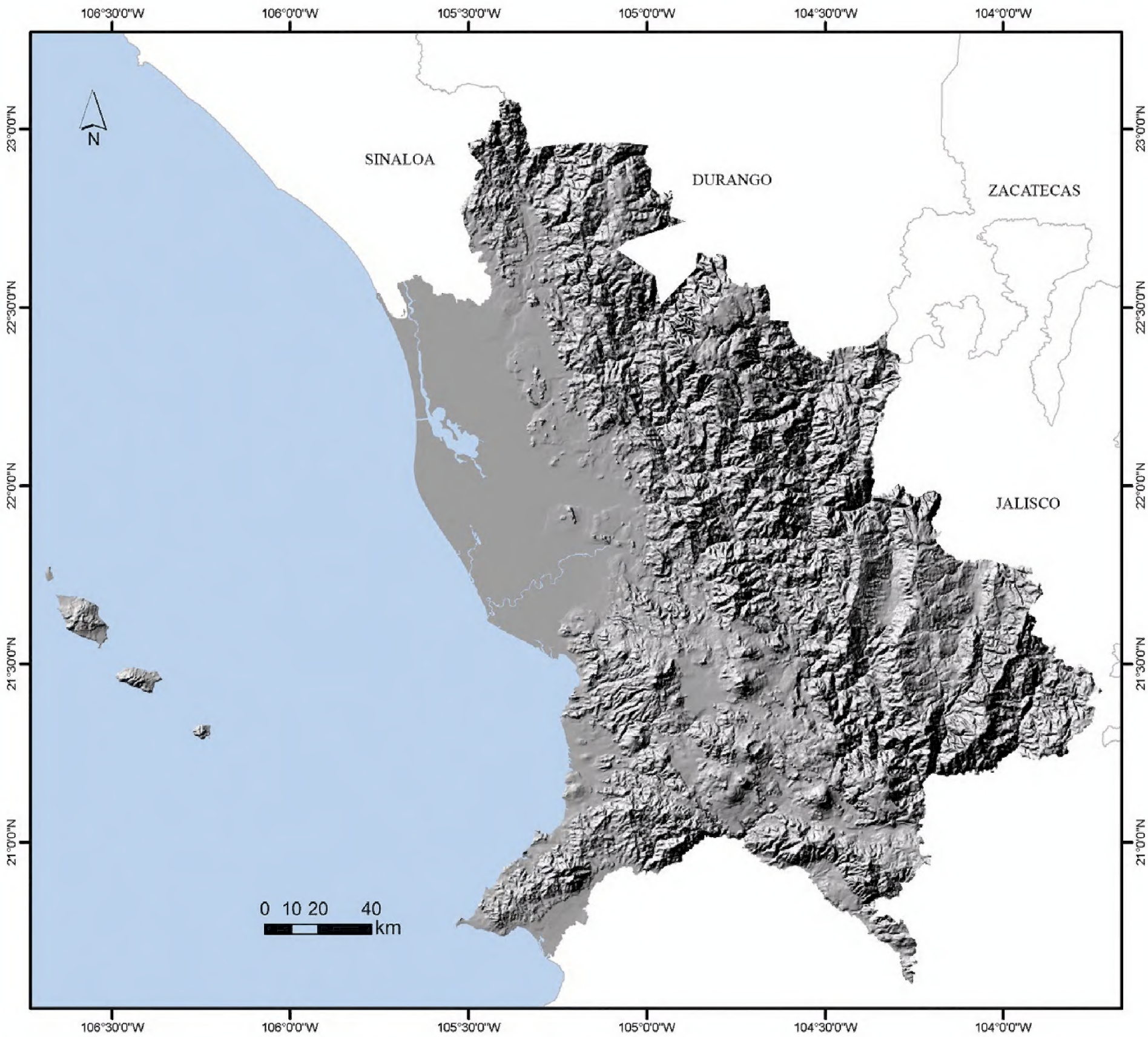

Figure 3. Topographical map of the State of Nayarit, Mexico (INEGI 2009).

mate is present in only 1.7% of the State's surface, in the extreme south of Nayarit (Fig. 4). Warm Humid, present in 0.56% of the State's territory is found in the central part of the State, as well as in a small region in the north.

Methods

We updated the list of amphibians and reptiles for Nayarit using our fieldwork (e.g. Loc-Barragán and Lazcano (2018); Loc-Barragán et al. (2018, 2019, 2020); Woolrich-Piña et al. (2021)), a thorough examination of the literature and records from VertNet.org. We follow Frost (2023) and AmphibiaWeb (2023) for amphibian names and Uetz et al. (2023) for reptile names; however, we did not include *Rhinocheilus antonii* Dugès, 1886, since we regard this taxon as a subspecies of *R. lecontei*, based on Manier (2004).

We created species accumulation curves for the total herpetofauna, as well as amphibians and reptiles separately, using the year of the first observation for each species in Nayarit. Generating species accumulation curves using this approach provides a reasonable estimate of herpetofaunal richness (see Raxworthy et al. (2012)). In addition, we recorded the conservation status and population trends of each species, based on the IUCN Red List 2022-2 (IUCN 2022), SEMARNAT (2019) and Environmental Vulnerability Scores from Wilson et al. (2013a, 2013b) and Johnson et al. (2015).

We determined the number of species shared with the four States that neighbour Nayarit using recent state lists: Jalisco (Cruz-Sáenz 2017); Durango (Lemos-Espinal et al. 2018); Sinaloa (Lemos-Espinal and Smith 2020) and Zacatecas (J. Sigala, personal communication), as well as updated State lists and a comprehensive checklist for the country of Mexico used in Smith and Lemos-Espinal (2022) and Lemos-Espinal and Smith (2023).

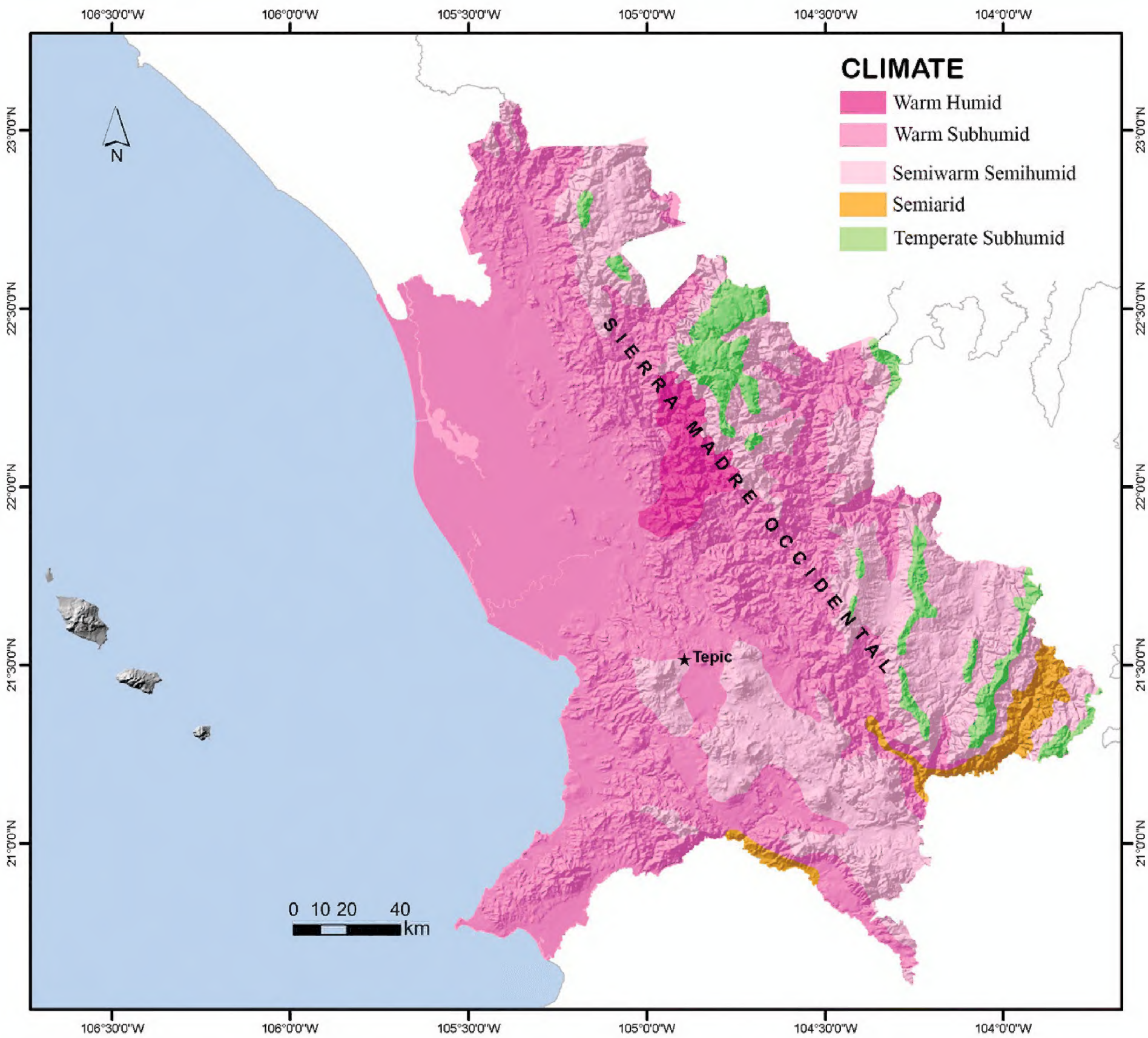

Figure 4. Climate map of the State of Nayarit, Mexico (modified from García – Comisión Nacional para el Conocimiento y Uso de la Biodiversidad 1998).

Results and discussion

Nayarit harbours 162 native species of amphibians and reptiles, representing 35 families (11 amphibian families [nine anurans and two salamanders] and 24 reptile families [one crocodilian, ten lizards, eight snakes and five turtles]) and 85 genera (20 amphibians and 65 reptiles) (Tables 1, 2). These include 37 species of amphibians (35 anurans and two salamanders) and 125 reptiles (one crocodile, 45 lizards, 69 snakes and 11 turtles). A species of *Plestiodon*, previously reported as *P. brevirostris*, occurs in Nayarit and, here, we report this undescribed species as *Plestiodon* aff. *brevirostris*. This is an increase of nine species from Woolrich-Piña et al. (2016), with an increase of one anuran, seven squamates and one turtle.

Two of the 162 native species are endemic to Nayarit: *Phyllodactylus cleofasensis* and *Thamnophis rossmani*. The most speciose amphibian family is Hylidae Rafinesque, 1815 and the most speciose reptile family is Colubridae Oppel, 1811 (Table 1). Additionally, eight species of amphibians and reptiles have been introduced to Nayarit: *Rana catesbeiana*, *Scinax staufferi*, *Anolis sagrei*, *Gehyra mutilata*, *Hemidactylus frenatus*, *Hemidactylus turcicus*, *Lepidodactylus lugubris* and *Indotyphlops braminus*.

We compiled a list of 28 species (nine amphibians, 19 reptiles: Table 3) that potentially occur in Nayarit, based on their distribution along the border with Sinaloa, Durango, Zacatecas and Jalisco. We used distributional records in Vertnet.org for the four neighbouring States and Nayarit to generate this list. As more herpetological work is done near the borders with the neighbouring States, we believe that these "likely to occur" species will be recorded for Nayarit.

Table 1. Native amphibians and reptiles of the State of Nayarit with distributional and conservation status. Ecoregion (ECR): (1 = Pacific Lowlands; 2 = Sierra Madre Occidental; 3 = Trans-Mexican Volcanic Belt; 4 = Sierra Madre del Sur; 5 = Nayarit Islands) according to INEGI 2018 and Blanco y Correa et al. 2021. IUCN Status: (DD = Data Deficient; LC = Least Concern, VU = Vulnerable, NT = Near Threatened; EN = Endangered; CR = Critically Endangered; NE = not evaluated), as well as the population trend, according to the IUCN Red List (The IUCN Red List of Threatened Species, Version 2022-2 (www.iucnredlist.org; accessed 25 August 2023); conservation status in Mexico according to SEMARNAT (2019) (Mex): (P = in danger of extinction, A = threatened, Pr = subject to special protection, NL – not listed); Environmental Vulnerability Score: (EVS – the higher the score the greater the vulnerability: low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–20; NE = not evaluated) from Wilson et al. (2013a, b) and Johnson et al. (2015); Global Distribution: 0 = Endemic to Nayarit; 1 = Endemic to Mexico; 2 = Shared between the US and Mexico; 3 = widely distributed from Mexico to Central or South America; 4 = widely distributed from the US to Central or South America; 5 = circumglobal distribution; 6 = Pacific and Indian Oceans. Date in which the first record appeared (1st); and Source of the first record.

	ECR	IUCN	EVS	Mex	Global	1st	Source
CLASS AMPHIBIA							
ORDER ANURA							
Family Bufonidae							
Anaxyrus kelloggi (Taylor, 1938)	1,2	LC (=)	H (14)	NL	1	1897	USNM 47865
Incilius marmoreus (Wiegmann, 1833)	1,4	LC (=)	M (11)	NL	1	1949	KU KUH 27718
Incilius mazatlanensis (Taylor, 1940)	1,2,3,4,5	LC (=)	M (12)	NL	1	1897	USNM46949
Incilius occidentalis (Camerano, 1879)	2,3	LC (=)	M (11)	NL	1	1897	USNM47171
Rhinella horribilis (Wiegmann, 1833)	1,2,3,4	NE	L (3)	NL	4	1894	CAS Herp 3219
Family Craugastoridae							
Craugastor augusti (Dugès, 1879)	2,3,4	LC (=)	L (8)	NL	2	1950	KU KUH 29776
Craugastor hobartsmithi (Taylor, 1937)	3,4	LC (=)	H (15)	NL	1	1956	CAS 17448–49
Craugastor occidentalis (Taylor, 1941)	1,2,3,4	LC (=)	M (13)	NL	1	1934	FMNH 106835
Craugastor pygmaeus (Taylor, 1937)	2,3,4	LC (?)	L (9)	NL	3	1963	CAS Herp 99231
Craugastor vocalis (Taylor, 1940)	2,3,4	LC (↓)	M (13)	NL	1	1950	KU KUH 28141
Family Eleutherodactylidae							
Eleutherodactylus modestus (Taylor, 1942)	4	LC (=)	H (16)	Pr	1	2020	ITSZ 1025
Eleutherodactylus jamesdixoni Devitt, Tseng, Taylor-Adair, Koganti, Timugura & Cannatella, 2023	2,3,4	NE	NE	NL	1	1954	KU KUH 37832
Eleutherodactylus pallidus (Duellman, 1958)	1,2,3,4,5	LC (=)	H (17)	Pr	1	1955	UIMNH Herps 71981
Eleutherodactylus teretistes (Duellman, 1958)	3	VU (?)	H (16)	NL	1	1956	UMMZ115451
Family Hylidae							
Dryophytes arenicolor (Cope, 1886)	2,3	LC (=)	L (7)	NL	2	1954	KU KUH 37739
Dryophytes eximius (Baird, 1854)	1,2,3,4	LC (=)	M (10)	NL	1	1894	CAS Herp 3160
Exerodonta smaragdina (Taylor, 1940)	2,3,4	LC (↓)	M (12)	Pr	1	1957	NHM-LACM: Herps839
Sarcohyla hapsa Campbell, Brodie, Caviedes-Solis, Nieto-Montes de Oca, Luja, Flores-Villela, García-Vázquez, Sarker & Wostl, 2018	2,3	LC (?)	NE	NL	1	2018	Campbell et al. (2018)
Smilisca baudinii (Duméril & Bibron, 1841)	1,2,3,4,5	LC (=)	L (3)	NL	4	1894	CAS Herp 314I+I25
Smilisca fodiens (Boulenger, 1882)	1,2,3,4	LC (=)	L (8)	NL	2	1897	USNM 47442
Tlalocohyla smithii (Boulenger, 1902)	1,2,3,4	LC (=)	M (11)	NL	1	1934	FMNH 105999
Trachycephalus vermiculatus (Cope, 1877)	1,4	NE	L (4)	NL	3	1962	KU KUH 74339
Triprion spatulatus Günther, 1882	1,4	LC (=)	M (13)	NL	1	1970	UTEP: Herp:6624
Family Leptodactylidae							
Leptodactylus melanonotus (Hallowell)	1,3,4	LC (=)	L (6)	NL	3	1932	UIMNH 32738
Family Microhylidae							
Gastrophryne mazatlanensis (Taylor, 1943)	1	NE	L (8)	NL	2	1959	UIMNH 81980
Hypopachus ustus (Cope, 1866)	1,4	LC (=)	L (7)	Pr	3	1981	USNM 238117
Hypopachus variolosus (Cope, 1866)	1,2,5	LC (=)	L (4)	NL	4	1934	FMNH 75789
Family Phyllomedusidae							
Agalychnis dacnicolor (Cope, 1864)	1,2,3,4	LC (↓)	M (13)	NL	1	1934	FMNH 98250
Family Ranidae							
Rana cora Pérez-Ramos & Luja Molina, 2022	1	NE	NE	NL	1	1955	CAS Herp 94259
Rana magnaocularis Frost & Bagnara, 1976	2,3,4	LC (?)	M (12)	NL	1	1949	UMMZ102125
Rana megapoda Taylor, 1942	3	NT (↓)	H (14)	Pr	1	1934	UIMNH 32081
Rana psilonota Webb, 2001	2,3	LC (?)	H (14)	NL	1	2003	MZFC 17290
Rana pustulosa Boulenger, 1883	2,3,4	LC (=)	L (9)	Pr	1	1934	FMNH 110851-852
Family Scaphiopodidae							
Scaphiopus couchii Baird, 1854	1	LC (=)	L (3)	NL	2	1897	USNM 47864
Spea multiplicata (Cope, 1863)	2,3	LC (=)	L (6)	NL	2	2014	Luja-Molina et al. (2014)

	ECR	IUCN	EVS	Mex	Global	1st	Source
ORDER CAUDATA							
Family Ambystomatidae							
Ambystoma rosaceum Taylor, 1941	2	LC (?)	H (14)	Pr	1	2003	Canseco-Márquez et al. (2007)
Family Plethodontidae							
Isthmura belli (Gray, 1850)	2	LC (?)	M (12)	A	1	1905	Gadow (1905)
CLASS REPTILIA							
ORDER CROCODYLIA							
Family Crocodylidae							
Crocodylus acutus (Cuvier, 1807)	1,5	VU (↑)	H (14)	Pr	4	1956	UPS PSM Herp-07724
ORDER SQUAMATA							
SUBORDER LACERTILIA							
Family Anguidae							
Barisia imbricata (Wiegmann, 1828)	2	LC (?)	H (14)	Pr	1	2016	Woolrich-Piña et al. (2021)
Elgaria kingii Gray, 1838	2,3	LC (=)	M (10)	Pr	2	1975	MSB-UNM: Herp:31877
Gerrhonotus liocephalus Wiegmann, 1828	3,5	LC (=)	L (6)	Pr	4	2014	MZUAN F0010
Family Corytophanidae							
Basiliscus vittatus Wiegmann, 1828	4	LC (=)	L (7)	NL	3	1976	USNM 238043
Family Dactyloidae							
Anolis nebulosus (Wiegmann, 1834)	1,2,3,4,5	LC (=)	M (13)	NL	1	1881	NHM-LACM: 81.10.1.85
Anolis sagrei Duméril & Bibron, 1837		IN	IN	IN	IN		
Family Eublepharidae							
Coleonyx elegans Gray, 1845	4	LC (=)	L (9)	A	3	2016	Woolrich-Piña et al. (2021)
Family Helodermatidae							
Heloderma horridum (Wiegmann, 1829)	1,2,3,4	LC (↓)	M (11)	A	1	1889	MCZ Herp R-6935
Family Iguanidae							
Ctenosaura pectinata (Wiegmann, 1834)	1,2,3,4,5	LC (↓)	H (15)	A	1	1885	USNM 14078
Iguana iguana (Linnaeus, 1758)	1,4	LC (?)	M (12)	Pr	3	1894	CAS Herp 3342
Family Phrynosomatidae							
Holbrookia elegans Bocourt, 1874	1	LC (=)	M (13)	NL	2	1954	NHM-LACM: Herps95207
Phrynosoma orbiculare (Linnaeus, 1766)	2	LC (=)	M (12)	A	1	2008	Reyes-Velasco et al. (2012)
Sceloporus albiventris Smith, 1939	2,3,4	NE	H (16)	NL	1	1894	USNM Amphibians and Reptiles 58813
Sceloporus asper Boulenger, 1897	3	LC (↓)	H (14)	Pr	1	1894	CAS Herp 3214
Sceloporus bulleri Boulenger, 1894	2	LC (=)	H (15)	NL	1	2020	Loc-Barragán and Woolrich-Piña (2020)
Sceloporus clarkii Baird & Girard, 1852	1,5	LC (=)	M (10)	NL	2	1894	CAS Herp 3328
Sceloporus dugesii Bocourt, 1874	2,3	LC (=)	M (13)	NL	1	1949	UIMNH 6469
Sceloporus grammicus Wiegmann, 1828	2	LC (=)	L (9)	Pr	2	2016	Woolrich-Piña et al. (2021)
Sceloporus heterolepis Boulenger, 1895	2	LC (?)	H (14)	NL	1	2015	Loc-Barragán et al. (2016)
Sceloporus horridus Wiegmann, 1834	3,4	LC (=)	M (11)	NL	1	1892	NHM-LACM: 92.2.8.24
Sceloporus huichol Flores-Villela, Smith, Campillo-García, Martínez-Méndez & Campbell, 2022	2,3	NE	NE	NL	1	2022	Flores-Villela et al. (2022)
Sceloporus jarrovii Cope, 1875	2	LC (=)	M (11)	NL	2	1892	NHM-LACM: 92.2.8.23
Sceloporus melanorhinus Bocourt, 1876	3,4	LC (=)	L (9)	NL	3	1897	USNM 64667
Sceloporus nelsoni Cochran, 1923	1,2,3,4	LC (=)	M (13)	NL	1	1934	FMNH 106436-438
Sceloporus poinsettii Baird & Girard, 1852	2	LC (=)	M (12)	NL	2	2014	Luja-Molina and Grünwald (2015)
Sceloporus scalaris Wiegmann, 1828	2	LC (=)	M (12)	NL	1	1970	Webb (1982)
Sceloporus shannonorum Langebartel, 1959	2,3	DD (?)	H (15)	NL	1	1959	NHM-LACM: Herps97384
Sceloporus spinosus Weigmann, 1828	1	LC (=)	M (12)	NL	1	ND	AMNH 15518
Sceloporus unicanthalis Smith, 1937	2,3	NE	H (16)	NL	1	ND	USNM 46626
Sceloporus utiformis Cope, 1864	1,2,3,4	LC (=)	H (15)	NL	1	1894	CAS Herp 3233
Urosaurus bicarinatus (Duméril, 1856)	1,4	LC (=)	M (12)	NL	1	1954	KUH 37737
Urosaurus ornatus (Baird & Girard, 1852)	2,5	LC (=)	M (10)	NL	2	1881	NHM-LACM: N/N
Family Phyllodactylidae							
Phyllodactylus cleofasensis Ramírez-Reyes, Barraza-Soltero, Nolasco-Luna, Flores-Villela & Escobedo-Galván, 2021	5	NE	NE	NL	0	2021	Ramírez-Reyes et al. (2021)
Phyllodactylus lanei Smith, 1935	4	LC (=)	H (15)	NL	1	1934	FMNH 94958
Phyllodactylus saxatilis Dixon, 1964	2,3,4	NE	NE	NL	1	1881	NHM-LACM: 81.10.1.90
Family Scincidae							
Marisora aquilonaria McCranie, Matthews & Hedges, 2020	1	NE	NE	NL	1	1992	Casas-Andreu (1992)
Plestiodon aff. *brevirostris* (Günther, 1860)	3	LC (=)	M (11)	NL	1	1970	NHM-LACM: Herps65135
Plestiodon callicephalus (Bocourt, 1879)	1,2,3	LC (=)	M (12)	NL	2	1959	NHM-LACM: Herps99505

	ECR	IUCN	EVS	Mex	Global	1st	Source
Plestiodon lynxe (Wiegmann, 1834)	2,3	LC (=)	M (10)	Pr	1	2007	Canseco-Márquez et al. (2007)
Plestiodon parviauriculatus (Taylor, 1933)	2	DD (?)	H (15)	Pr	1	2020	Loc-Barragán et al. (2020)
Plestiodon parvulus (Taylor, 1933)	1,2,4	DD (?)	H (15)	NL	1	1910	USNM 56903
Family Teiidae							
Aspidoscelis communis (Cope, 1878)	4,5	LC (=)	H (14)	Pr	1	1881	NHM-LACM: 81.10.1.88
Aspidoscelis costatus (Cope, 1878)	1,2,3,4	LC (=)	M (11)	Pr	1	1859	NHM-LACM: Herps 53169
Aspidoscelis lineattissimus (Cope, 1878)	4	LC (=)	H (14)	Pr	1	1894	CAS Herp 3344
Holcosus sinister (Wiegmann, 1834)	3,4	NE	M (13)	NL	1	1956	UAZ 21333
SUBORDER SERPENTES							
Family Boidae							
Boa sigma (Smith, 1943)	1,2,3,4,5	NE	M (10)	NL	1	1897	USNM 46484
Family Colubridae							
Conopsis nasus (Günther, 1858)	2	LC (=)	M (11)	NL	1	1963	UAZ 24127
Drymarchon melanurus (Duméril, Bibron & Duméril, 1854)	1,2,3,4,5	LC (=)	L (6)	NL	4	1925	CAS Herp 58993
Drymobius margaritiferus (Schlegel, 1837)	1,3,4	LC (=)	L (6)	NL	4	1913	USNM 51480
Gyalopion quadrangulare (Günther, 1893)	1	LC (=)	M (11)	Pr	2	1956	UAZ 20734
Lampropeltis greeri Webb, 1961	2	NE	NE	NL	1	2010	UTADC 6833
Lampropeltis polyzona Cope, 1860	1,2,3,4,5	LC (?)	M (11)	NL	1	1881	NHM-LACM:81.10.1.97
Leptophis diplotropis (Günther, 1872)	1,3,4,5	LC (=)	H (14)	A	1	1881	NHM-LACM: 81.10.1.104
Masticophis bilineatus Jan, 1863	2,5	LC (=)	M (11)	NL	2	1897	USNM 46417
Masticophis flagellum Shaw, 1802	2	LC (=)	L (8)	A	2	2020	ITSZ LEZ 201
Masticophis mentovarius (Duméril, Bibron & Duméril, 1854)	1,3,4	LC (?)	L (6)	A	3	1897	USNM24681
Mastigodryas cliftoni (Hardy, 1964)	2	DD (?)	H (14)	NL	1	1998	Ponce-Campos and Huerta-Ortega (1998)
Mastigodryas melanolomus (Cope 1868)	2,3,4,5	LC (=)	L (6)	NL	3	1881	NHM-LACM: 81.10.1.103
Oxybelis microphthalmus Barbour & Amaral, 1926	1,3,4,5	NE	NE	NL	2	1881	NHM-LACM: 81.10.1.107
Pituophis deppei (Duméril, 1853)	2	LC (=)	H (16)	NL	1	1894	CAS Herp 3126
Pseudoficimia frontalis (Cope, 1864)	2	LC (=)	M (10)	NL	3	1958	UIMNH 83010
Rhinocheilus lecontei Baird & Girard, 1853	1	LC (=)	L (8)	NL	2	1958	UIMNH 84165
Salvadora bairdii Jan & Sordelli, 1860	3	LC (=)	H (15)	Pr	1	2016	Woolrich-Piña et al. (2016)
Salvadora grahamiae Baird & Girard, 1853	2	LC (=)	M (10)	NL	2	1898	MNHN -RA 1898.251
Salvadora mexicana (Duméril, Bibron & Duméril, 1854)	2,3,4	LC (=)	H (15)	Pr	1	1958	UIMNH 84204
Senticolis triaspis (Cope, 1866)	2,3,4	LC (=)	L (6)	NL	4	1956	UIMNH83492
Sonora mutabilis Stickel, 1943	2,3,4	LC (?)	H (14)	NL	1	ND	AMNH 74951
Sympholis lippiens Cope, 1862	3	DD (?)	H (14)	NL	1	1894	CAS Herp 3127
Tantilla bocourti (Günther, 1895)	3,5	LC (?)	L (9)	NL	1	1964	McDiarmid et al. (1976)
Tantilla calamarina Cope, 1866	3,4,5	LC (=)	M (12)	Pr	1	1881	NHM LACM 81.10.1.12
Tantilla ceboruca Canseco-Márquez, Smith, Ponce-Campos, Flores-Villela & Campbell, 2007	3	NE	H (16)	NL	1	2003	Canseco-Márquez et al. (2007)
Tantilla yaquia Smith, 1942	2,3,4	LC (=)	M (10)	NL	2	ND	AMNH7 4949
Trimorphodon paucimaculatus Taylor, 1936	1,5	NE	H (15)	NL	1	1954	UPS PSM Herp-07530
Trimorphodon tau Cope, 1870	2,3,4	LC (=)	M (13)	NL	1	1956	TCWC Herpetology 12609
Family Dipsadidae							
Coniophanes lateritius Cope, 1862	3,4	DD (?)	M (13)	NL	1	1963	NHM-LACM: Herps9496
Diadophis punctatus (Linnaeus, 1766)	2,3	LC (=)	L (4)	NL	2	1959	NHM-LACM: Herps103860
Enulius oligostichus Smith, Arndt & Sherbrook, 1967	3,4	DD (?)	H (15)	Pr	1	1962	NHM-LACM: Herps36232
Geophis annuliferus Boulenger, 1894	3,4,5	LC (=)	M (13)	Pr	1	1925	CAS Herp 58680
Geophis dugesii Bocourt, 1883	3	LC (?)	M (13)	NL	1	2015	Luja-Molina and Grünwald (2015)
Hypsiglena affinis Boulenger, 1894	2,3,4	NE	H (14)	Pr	1	1962	UIMNH 85582
Hypsiglena torquata (Günther, 1860)	1,2,5	LC (=)	L (8)	Pr	1	1957	UIMNH 83059
Imantodes gemmistratus (Cope, 1861)	1,2,3,4,5	LC (=)	L (6)	Pr	3	1881	NHM-LACM: 81.10.1.101
Leptodeira maculata (Hallowell, 1861)	1,4	LC (=)	L (7)	Pr	1	1894	CAS Herp 3128
Leptodeira polysticta (Günther, 1895)	3,4	NE	L (8)	NL	3	1937	FMNH 95206
Leptodeira punctata (Peters, 1866)	1	LC (?)	H (17)	NL	1	1954	KU KUH 37598
Leptodeira splendida Günther, 1895	2,3,4	LC (?)	H (14)	NL	1	1964	CAS Herp 96885
Manolepis putnami (Jan, 1863)	3,4	LC (=)	M (13)	NL	1	1973	USNM 197999
Rhadinaea hesperia Bailey, 1940	3,4,5	LC (=)	M (10)	Pr	1	1960	NHM-LACM: Herps 103653
Rhadinaea taeniata (Peters, 1863)	3	DD (?)	M (13)	NL	1	2015	Luja-Molina and Grünwald (2015)
Sibon nebulatus (Linnaeus, 1758)	1,3	LC (=)	L (5)	NL	3	1959	NHM-LACM: Herps103863
Tropidodipsas philippii (Jan, 1863)	2,4	LC (=)	H (14)	Pr	1	1959	UIMNH 84567

	ECR	IUCN	EVS	Mex	Global	1st	Source
Family Elapidae							
Hydrophis platurus (Linnaeus, 1766)	1	LC (=)	NE	NL	6	1925	CAS Herp 58992
Micruroides euryxanthus (Kennicott, 1860)	2,3	LC (=)	H (15)	A	2	2013	MZFC 28306
Micrurus browni Schmidt & Smith, 1943	2,3,4	LC (=)	L (8)	Pr	3	1956	UIMNH 40369
Micrurus distans (Kennicott, 1860)	2,3	LC (=)	H (14)	Pr	1	1956	UMMZ 114443
Family Leptotyphlopidae							
Rena humilis Baird &Girard, 1853	1,3,4	LC (=)	L (8)	NL	2	1956	CAS SUR 19243
Family Loxocemidae							
Loxocemus bicolor Cope, 1861	1,2,4	LC (?)	M (10)	Pr	3	1957	UIMNH 82538
Family Natricidae							
Storeria storerioides (Cope, 1865)	2,3	LC (=)	M (11)	NL	1	1963	UAZ 26389
Thamnophis cyrtopsis (Kennicott, 1860)	2,3	LC (=)	L (7)	A	4	1980	CAS Herp 169687
Thamnophis eques (Reuss, 1834)	2	LC (=)	L (8)	A	2	1897	USNM 46429
Thamnophis errans Smith, 1942	2	LC (?)	H (16)	NL	1	1979	CAS Herp 169662
Thamnophis melanogaster (Peters, 1864)	2,3	EN (↓)	H (15)	A	1	1934	FMNH 126726
Thamnophis nigronuchalis Thompson, 1957	2	DD (?)	M (12)	Pr	1	1979	CAS Herp 169660
Thamnophis pulchrilatus (Cope, 1885)	2	LC (?)	H (15)	NL	1	1897	USNM 46420
Thamnophis rossmani Conant, 2000	3	DD (?)	H (18)	NL	0	1934	UIMNH 18836
Thamnophis validus (Kennicott, 1860)	1,3,4	LC (=)	M (12)	NL	1	1934	FMNH 115618
Family Viperidae							
Agkistrodon bilineatus (Günther, 1863)	1,2,3,4	NT (↓)	M (11)	Pr	3	1881	NHM LACM 81.10.1.95
Crotalus armstrongi Campbell, 1979	3	NE	H (18)	NL	1	1950	KU KUH 29501
Crotalus basiliscus (Cope, 1864)	1,2,3,4	LC (=)	H (16)	Pr	1	1956	UIMNH 84705
Crotalus campbelli Bryson, Linkem, Dorcas, Lathrop, Jones, Alvarado-Díaz, Grünwald & Murphy, 2014	3	NE	H (17)	NL	1	2015	Luja-Molina and Grünwald (2015)
Crotalus lepidus (Kennicott, 1861)	2,3	LC (=)	M (12)	Pr	2	1897	USNM 46333
Crotalus molossus Baird & Girard, 1853	2,3	LC (=)	L (8)	Pr	2	1977	MSB.UNM: Herp:32085
Crotalus pricei Van Denburgh, 1895	2,3	LC (?)	H (14)	Pr	2	1952	Klauber (1952)
Crotalus willardi Meek, 1905	2	LC (=)	M (13)	Pr	2	2021	Woolrich-Piña et al. (2021)
ORDER TESTUDINES							
Family Cheloniidae							
Chelonia mydas (Linnaeus, 1758)	1,5	EN (↓)	NE	P	5	1883	CAS Herp 4860
Eretmochelys imbricata Linnaeus, 1766	1,5	CR (↓)	NE	P	5	ND	AMNH 78717
Lepidochelys olivacea (Eschscholtz, 1829)	1,5	VU (↓)	NE	P	5	1956	UPS PSM Herp-07725
Family Dermochelyidae							
Dermochelys coriacea (Vandelli, 1761)	1,5	VU (↓)	NE	P	5	2007	Sarti-Martínez et al. (2007)
Family Emydidae							
Terrapene nelsoni Stejneger, 1925	2	DD	H (18)	Pr	1	1897	USNM 46252
Trachemys ornata (Gray, 1831)	1,3,4	VU (↓)	H (19)	NL	1	1961	UIMNH 12922
Family Geoemydidae							
Rhinoclemmys pulcherrima (Gray, 1855)	2,3,4	NE	L (8)	A	3	1897	USNM 46305
Family Kinosternidae							
Kinosternon cora Loc-Barragán, Reyes-Velásco, Woolrich-Piña, Grünwald, Venegas de Anaya, Rangel-Méndoza & López-Luna, 2020	1	NE	NE	NL	1	2020	Loc-Barragán et al. (2020)
Kinosternon hirtipes (Wagler, 1830)	2	LC (↓)	M (10)	Pr	2	1955	UIMNH 85855
Kinosternon integrum LeConte, 1854	1,2,3,4,5	LC (=)	M (11)	Pr	1	1881	NHM LACM 81.10.1.74
Kinosternon vogti López-Luna, Cupull-Magaña, Escobedo-Galván, González-Hernández, Centenero-Alcalá, Rangel-Mendoza, Ramírez-Ramírez & Cazares-Hernández 2018	4	NL	NE	P	1	2021	Rosales-Martínez et al. (2021)

Table 2. Summary of native species present in Nayarit by class, family, order and suborder. Status summary indicates the number of species found in each IUCN conservation status in the order DD, LC, NT, VU, EN, CR (see Table 1 for abbreviations). Mean EVS is the mean Environmental Vulnerability Score, scores ≥ 14 are considered to have high vulnerability (Wilson et al. 2013a, 2013b) and conservation status in Mexico according to SEMARNAT (2010) in the order NL, Pr, A, P (see Table 1 for abbreviations).

Scientific Name	Genera	Species	IUCN	EVS ($\bar{X}$)	SEMARNAT
CLASS AMPHIBIA			DD, LC, NT, VU, EN, CR		NL, Pr, A, P
ORDER ANURA	18	35	0,28,1,1,0,0	9.91	30,5,0,0
Bufonidae	2	5	0,4,0,0,0,0	10.2	5,0,0,0
Craugastoridae	1	5	0,5,0,0,0,0	11.6	5,0,0,0
Eleutherodactylidae	1	4	0,2,0,1,0,0	15.25	2,2,0,0
Hylidae	7	9	0,8,0,0,0,0	8.5	8,1,0,0
Leptodactylidae	1	1	0,1,0,0,0,0	6	1,0,0,0

Scientific Name	Genera	Species	IUCN	EVS ($\bar{X}$)	SEMARNAT
Microhylidae	2	3	0,2,0,0,0,0	6.33	2,1,0,0
Phyllomedusidae	1	1	0,1,0,0,0,0	13	1,0,0,0
Ranidae	1	5	0,3,1,0,0,0	10.4	3,2,0,0
Scaphiopodidae	2	2	0,2,0,0,0,0	4.5	2,0,0,0
ORDER CAUDATA	2	2	0,2,0,0,0,0	13	0,1,1,0
Ambystomatidae	1	1	0,1,0,0,0,0	14	0,1,0,0
Plethodontidae	1	1	0,1,0,0,0,0	12	0,0,1,0
SUBTOTAL	20	37	0,30,1,1,0,0	10.1	30,6,1,0
CLASS REPTILIA					
ORDER CROCODYLIA	1	1	0,0,0,1,0,0	14	0,1,0,0
Crocodylidae	1	1	0,0,0,1,0,0	14	0,1,0,0
ORDER SQUAMATA	56	113	10,85,1,0,1,0	11.78	69,33,11,0
SUBORDER LACERTILIA	18	44	3,34,0,0,0,0	12.03	29,11,4,0
Anguidae	3	3	0,3,0,0,0,0	10	0,3,0,0
Corytophanidae	1	1	0,1,0,0,0,0	7	1,0,0,0
Dactyloidae	1	1	0,1,0,0,0,0	13	1,0,0,0
Eublepharidae	1	1	0,1,0,0,0,0	9	0,0,1,0
Helodermatidae	1	1	0,1,0,0,0,0	11	0,0,1,0
Iguanidae	2	2	0,2,0,0,0,0	13.5	0,1,1,0
Phrynosomatidae	4	22	1,18,0,0,0,0	12.57	19,2,1,0
Phyllodactylidae	1	3	0,1,0,0,0,0	11.5	3,0,0,0
Scincidae	2	6	2,3,0,0,0,0	12.6	4,2,0,0
Teiidae	2	4	0,3,0,0,0,0	13	1,3,0,0
SUBORDER SERPENTES	38	69	7,51,1,0,1,0	11.54	40,22,7,0
Boidae	1	1	0,0,0,0,0,0	10	1,0,0,0
Colubridae	17	28	2,22,0,0,0,0	11.04	21,4,3,0
Dipsadidae	11	17	3,12,0,0,0,0	11	9,8,0,0
Elapidae	3	4	0,4,0,0,0,0	12.33	1,2,1,0
Leptotyphlopidae	1	1	0,1,0,0,0,0	8	1,0,0,0
Loxocemidae	1	1	0,1,0,0,0,0	10	0,1,0,0
Natricidae	2	9	2,6,0,0,1,0	12.66	5,1,3,0
Viperidae	2	8	0,5,1,0,0,0	13.62	2,6,0,0
ORDER TESTUDINES	8	11	1,2,0,3,1,1	13.2	2,3,1,5
Cheloniidae	3	3	0,0,0,1,1,1	–	0,0,0,3
Dermochelyidae	1	1	0,0,0,1,0,0	–	0,0,0,1
Emydidae	2	2	1,0,0,1,0,0	18.5	1,1,0,0
Geoemydidae	1	1	0,0,0,0,0,0	8	0,0,1,0
Kinosternidae	1	4	0,2,0,0,0,0	10.5	1,2,0,1
SUBTOTAL	65	125	11,87,1,4,2,1	11.75	71,37,12,5
TOTAL	85	162	11,119,2,5,2,1	11.35	101,43,13,5

The species accumulation curves indicate that there have been three periods of rapid growth in the known species richness of the herpetofauna of Nayarit (Fig. 5). The first period was in the 1890s and represents the work of A.C. Buller, E. Nelson and E. Goldman, G. Eisen and F.H. Vaslit, J. Van Denburgh and L. Diguet, amongst others. The second period of rapid increases in the known species richness was in the 1950s and 1960s and was particularly dramatic for reptiles. This increase reflects the work of A.E. Leviton and H.E. Munsterman, A.S. Lokley, A.R. Phillips, C.H. Lowe, D. Langebartel, J. Schaffner and E. Widdows, J. Dixon, W. Duellman, F.A. Shannon and F.L. Humphrey, J. Maris, M.L. Johnson, T.H. Lewis, R. Abbuhl, G. Gates and A. Maas, R.B. Loomis and R.G. Webb, amongst others. The final increase has been in the past decade or so and is almost entirely the result of an increase in the number of reptiles identified in Nayarit. The current period of increased knowledge of the herpetofauna of Nayarit is the result of work by herpetologists,

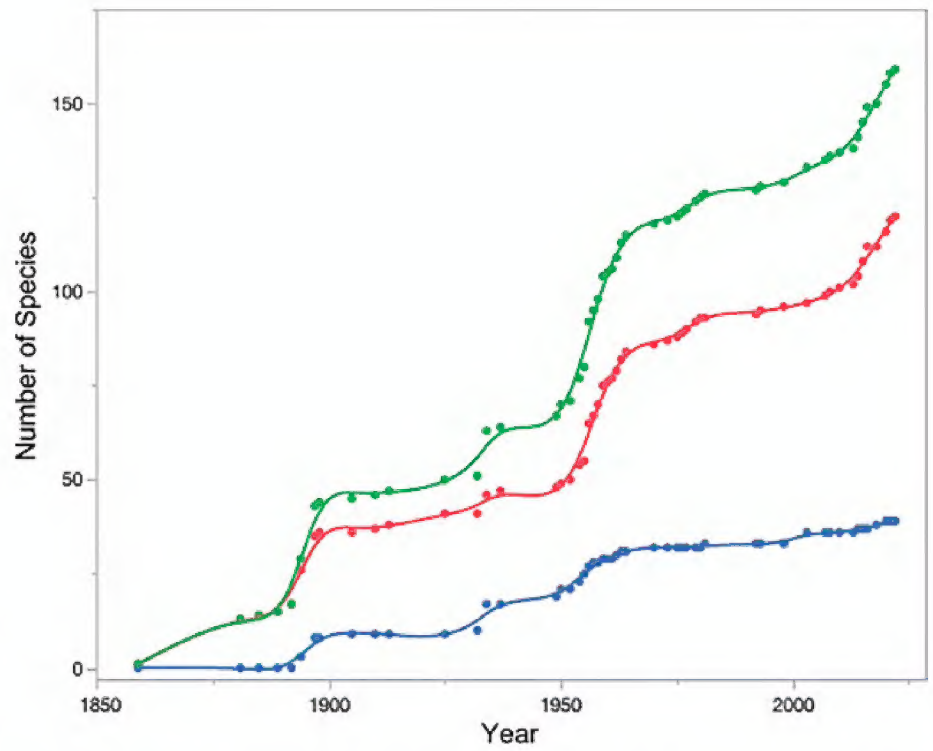

Figure 5. Species accumulation curves for all reptiles and amphibians (green), reptiles (red) and amphibians (blue) in Nayarit, Mexico.

Table 3. List of amphibian and reptile species that potentially occur in Nayarit. Region abbreviations: SMO (Sierra Madre Occidental); SMS (Sierra Madre del Sur); PL (Pacific Lowlands); TMVB (Trans-Mexican Volcanic Belt.

Taxon	Likely to occur in:
Class Amphibia	
Order Anura	
Family Bufonidae	
Anaxyrus compactilis (Wiegmann, 1833)	SMO
Anaxyrus debilis (Girard, 1854)	SMO
Anaxyrus mexicanus (Brocchi, 1879)	SMO
Anaxyrus punctatus (Baird & Girard, 1852)	PL and SMO
Family Eleutherodactylidae	
Eleutherodactylus saxatilis (Webb, 1962)	SMO
Eleutherodactylus wixarika Reyes-Velasco, Ahumada-Carrillo, Burkhardt & Devitt, 2015	SMO
Ranidae	
Rana neovolcanica (Hillis & Frost, 1985)	TMVB
Orden Gymnophiona	
Dermophiidae	
Dermophis oaxacae (Mertens, 1930)	PL and SMS
Order Caudata	
Family Ambystomatidae	
Ambystoma velasci Dugès, 1888	SMO
Class Reptilia	
Suborder Lacertilia	
Anguidae	
Barisia ciliaris (Smith, 1942)	SMO
Eublepharidae	
Coleonyx fasciatus (Boulenger, 1885)	SMS
Phrynosomatidae	
Callisaurus draconoides Blainville, 1835	PL
Phrynosoma asio Cope, 1864	SMS
Teiidae	
Aspidoscelis gularis (Baird & Girard, 1852)	TMVB
Scincidae	
Plestiodon bilineatus (Tanner, 1958)	SMO
Xantusiidae	
Xantusia sanchezi Bezy & Flores-Villela, 1999	SMO
Suborder Serpientes	
Colubridae	
Conopsis biserialis (Taylor & Smith, 1942)	TMVB
Lampropeltis webbi Bryson, Dixon & Lazcano, 2005	SMO
Masticophis taeniatus (Hallowell, 1852)	SMO
Pituophis catenifer (Blainville, 1835)	
Adelophis foxi Rossman & Blaney, 1968	SMO
Dipsadidae	
Conophis vittatus Peters, 1860	SMS
Pseudoleptodeira latifasciata (Günther, 1894)	SMS
Natricidae	
Thamnophis marcianus (Baird & Girard, 1853)	SMO
Viperidae	
Crotalus lannomi Tanner, 1966	SMS
Crotalus stejnegeri Dunn, 1919	SMO
Crotalus polystictus (Cope, 1865)	SMO
Geoemydidae	
Rhinoclemmys rubida (Cope, 1870)	SMS

based in Mexico: C. Grünwald, G. Woolrich-Piña, I. Ahumada-Carrillo, J. Reyes-Velasco, J. Loc-Barragán and M. López-Luna, amongst others. The species accumulation curves, particularly for reptiles and total herpetofauna, do not level off, suggesting that the knowledge of the herpetofauna, especially the reptiles, is incomplete and more species are likely to be described and discovered as modern molecular tools and renewed fieldwork continues.

Recent taxonomical changes

In the years since the writing and publication of Woolrich-Piña et al. (2016), there have been several taxonomic changes or additions with regard to the herpetofauna of Nayarit. In this section, we provide some information on these recent changes and additions.

Devitt et al. (2023) described a new species of *Eleutherodactylus* from the mountainous region of Sinaloa and Nayarit, this species representing populations of this region previously regarded as *Eleutherodactylus nitidus*. Campbell et al. (2018) described a new hylid frog from the southern Sierra Madre Occidental from Durango and southern Sinaloa, along the southern edge of the Mexican Plateau from Michoacán to Morelos. This new frog species replaces *Sarcohyla bistincta* in these States, including Nayarit. Pérez-Ramos and Luja-Molina (2022) studied populations of *R. forreri* from the Pacific Lowlands and distinguished two new species, one of them, *Rana cora*, inhabiting the States of Chihuahua, Sonora, Sinaloa, Nayarit and Colima. Flores-Villela et al. (2022) described a new species of *Sceloporus* from the mountainous region of Jalisco and Nayarit, this species representing populations of this region previously regarded as *Sceloporus torquatus*. Ramírez-Reyes et al. (2021a) presented genomic, phyllogenomic and morphological evidence showing that *Phyllodactylus* populations from María Cleofas Island, Nayarit, represent a new species related to *P. saxatilis*. Ramírez-Reyes et al. (2021b) showed that the arrangement of the subspecies *P. tuberculosus saxatilis* is polyphyletic. To avoid this polyphyletic arrangement and the use of infraspecific categories, they elevated this subspecies to the rank of species, whose distribution includes Nayarit. MacCranie et al. (2020) conducted a revision of the genus *Marisora* from Mexico and Central America and found support for the description of four new species, amongst them *M. aquilonaris* which includes populations previously regarded as *M. brachypoda* in Nayarit, south to Guerrero, Morelos and Puebla in the east. Hansen and Salmon (2017) presented a taxonomic update and a distribution analysis of the *Lampropeltis mexicana* group, providing morphological evidence that indicates the presence of *L. greeri* in Nayarit. Jadin et al. (2020) revised the taxonomy of *Oxybelis aeneus* recognising five additional taxa, including *O. microphthalmus* which is found in Nayarit. Grünwald et al. (2021) presented a molecular phylogeny of the Mexican snail-eating snakes, finding evidence that *Tropidodipsas annulifera* is more closely related to the genus *Geophis* than to other snail-eating snake genera, for which they

proposed the new combination *Geophis annuliferus* Boulenger, 1894. Reyes-Velasco et al. (2020) demonstrated in the phylogenetic relationships within the genus *Micrurus*, that individuals distributed on the western coast of Mexico, from Nayarit to Guerrero, including *M. proximans*, represent *M. browni*. Loc-Barragán et al. (2020) showed that populations of *K. chimalhuaca* in Nayarit represent a new species (*K. cora*).

General distribution

Twenty-four of the 37 species of amphibians found in Nayarit are endemic to Mexico (Table 1). This compares to 21 country endemics reported by Woolrich-Piña et al. (2016). Eleven of these 24 endemics are distributed mainly in the Pacific Lowlands. Five more are typical of western-central Mexico, mainly in the States of Sinaloa, Nayarit, Jalisco, Colima and Michoacán. Another five are distributed in several ecoregions, including the Pacific Lowlands, Trans-Mexican Volcanic Belt, Mesa Central and Sierra Madre del Sur. One species (*Dryophytes eximius* [Baird, 1854]) is widely distributed in both Sierra Madre Occidental and Sierra Madre del Sur and the Trans-Mexican Volcanic Belt. Another one (*Isthmura belli* [Grey, 1850]) is found in central Mexico with isolated populations in Tamaulipas and Nayarit. Finally, the last one (*Ambystoma rosaceum* Taylor, 1941) ranges mainly in the Sierra Madre Occidental. Six more of the 37 amphibian species found in Nayarit are distributed in the United States and Mexico. Four more are species distributed in Mexico and Central America or even South America. The last three amphibian species found in Nayarit are distributed from extreme south-eastern United States to Central America or South America (Table 1).

The only crocodile that inhabits Nayarit, *Crocodylus acutus* (Cuvier, 1807), is widely distributed with populations in southern Florida, USA, the Caribbean, the Gulf of Mexico, the Mexican Pacific, Central and South America.

Thirty-one of the 44 species of lizards that inhabit Nayarit are endemic to Mexico, one of them (*Phyllodactylus cleofasensis*) to Nayarit (Table 1). This is an increase of seven country endemic lizards from the 24 reported in Woolrich-Piña et al. (2016). Sixteen of the other 30 are distributed mainly in the Pacific Lowlands, but can also inhabit in the Sierra Madre Occidental, Sierra Madre del Sur, Mesa Central, Trans-Mexican Volcanic Belt and Balsas Depression. Five more are typical of western-central Mexico. Another six are widely distributed in the Sierra Madre Occidental, Mesa del Centro, Trans-Mexican Volcanic Belt and some of them even in the Sierra Madre del Sur, Balsas Depression and Sierra Madre Oriental. One more, *Sceloporus spinosus* Weigmann, 1828, occurs in the Mesa del Centro, Trans-Mexican Volcanic Belt, Sierra Madre Oriental and Sierra Madre del Sur. Another one, *Plestiodon parviauriculatus* (Taylor, 1933), is found in the western slopes of the Sierra Madre Occidental. The last of the Mexican endemic lizards (*Plestiodon* aff. *brevirostris* [Günther, 1860]) is mainly found in the Trans-Mexican Volcanic Belt. Eight more of the 44 species of lizards found in Nayarit are distributed in the United States and Mexico. Four more are species of lizards distributed in Mexico and Central America or even South America. The last species of lizard (*Gerrhonotus liocephalus* Weigmann, 1828), found in Nayarit, is distributed from extreme south-eastern United States to Central America.

One of the 69 species of snakes that occur in Nayarit is endemic to Nayarit (*Thamnophis rossmani*) and 39 are endemic to Mexico (Table 1). This matches the number of country endemics reported by Woolrich-Piña et al. (2016). Of the 29 species of snakes not endemic to Mexico that inhabit Nayarit, 15 are found in the United States and Mexico. Nine are distributed from Mexico to Central or South America. Four are found from central or southern United States to Central or South America. The last one is a sea snake distributed across the Pacific and Indo-Pacific Oceans.

Five of the 11 species of turtles found in Nayarit are endemic to Mexico (Table 1). This is an increase of one species over the four reported in Woolrich-Piña et al. (2016). One, *Kinosternon hirtipes* (Wagler, 1830) is found in the United States and Mexico. Another one (*Rhinoclemmys pulcherrima* (Gray, 1855) is found in Mexico and Central America. The other four have a circumtropical or circumglobal distribution (Table 1).

Ecoregions

The ecoregion containing the most species of amphibians and reptiles in Nayarit is the Trans-Mexican Volcanic Belt with 96 species inhabiting it, followed by the Sierra Madre Occidental with 95 species and the Sierra Madre del Sur with 77 species. The Pacific Lowlands with 62 species and the Nayarit Islands with 31 species are the least species-rich ecoregions by species of amphibians and reptiles in Nayarit. The mountain habitats in Trans-Mexican Volcanic Belt, Sierra Madre Occidental and Sierra Madre del Sur, host more species than the lowlands habitats in Pacific Lowlands and Nayarit Islands, such that Nayarit is dominated by species with temperate affinities of the first three ecoregions (Table 4). In general, the pattern of species richness amongst the ecoregions we found is similar to that in Woolrich-Piña et al. (2016); however, in the scheme we used, the Coastal Plain of Woolrich-Piña et al. (2016) is divided into the Pacific Lowlands and the Sierra Madre del Sur.

In general, the amphibians of the five ecoregions of Nayarit have none or a low percentage of species protected by the IUCN and SEMARNAT, except for the Trans-Mexican Volcanic Belt that has one species (*Eleutherodactylus teretistes* [VU]) in the IUCN protection categories and the Sierra Madre Occidental, which has one species (*Isthmura bellii* [A]) in the SEMARNAT protection categories and, although the

percentages of amphibian species considered at high risk by the EVS are very different to those of IUCN and SEMARNAT, these are still relatively low, the highest of them in the Nayarit Islands with one (*Eleutherodactylus pallidus* [H-17]) of four species with a high risk EVS (Table 5).

On the other hand, the reptiles of the five ecoregions of Nayarit have greater protection than amphibians; however, these remain relatively low, not only for the IUCN and SEMARNAT, but also for the EVS assessments. These three lists have similar percentages for the Nayarit Islands: IUCN = 21.7%; SEMARNAT = 22.2%; and EVS = 23.8%. For the remaining four ecoregions, the EVS percentages are higher than those of the IUCN and SEMARNAT, in some cases more than double or triple (for example: Sierra Madre Occidental and Trans-Mexican Volcanic Belt) (Table 5).

Conservation status

A total of eight (= 5.8% [8/138]) species of amphibians and reptiles in Nayarit are IUCN-listed (i.e. Vulnerable, Endangered or Critically Endangered), 18 (= 11.1% [18/162]) are placed in a protected category (excluding NL and Pr, this last category being equivalent to the LC category of IUCN) by SEMARNAT and 49 (= 33.3% [49/147]) are categorised as high risk by the EVS (Table 2). Woolrich-Piña et al. (2016) found 6.7% were in threatened categories of the IUCN Red List, 11.4% in a protected category by SEMARNAT and 33.8% with high EVS (did not include marine species). For amphibians, 3.1% (1/32) are IUCN-listed, 2.7% (1/37) are protected by SEMARNAT and 23.5% (= 8/34) are at high risk according to the EVS (Table 2; Fig. 6). For reptiles, 6.6% (7/106) are listed by the IUCN, 13.6% (17/125) are protected by SEMARNAT and 36.3% (41/113) are at high risk according to the EVS (Table 2; Fig. 6). This summary suggests that the herpetofauna of Nayarit has relatively few species of conservation concern at a global and national scale (IUCN and SEMARNAT lists), but there might be greater conservation concerns using the EVS which is based on information specific to Mexico and Central America and so might be more likely to reflect the conservation status and needs of the Nayarit herpetofauna. The SEMARNAT list is also based on information specific to Mexico and, although this institution released a new update in 2019, it does not appear that conservation statuses have been re-evaluated since 2010 because all Nayarit statuses for amphibians and reptiles have remained the same. Therefore, although it is a local evaluation, it might not reflect the current conservation status of the species and so does not take into account the numerous recent taxonomic changes and the description of new species or more recent changes in conservation status or threats. There are several taxa that, based on their IUCN listing, SEMARNAT category or their EVS, are of conservation concern. Families with species of particular conservation concern include Eleutherodactylidae, Ranidae, Ambystomatidae, Crocodylidae, Eublepharidae, Helodermatidae, Iguanidae, Phyllodactylidae, Colubridae, Dipsadidae, Elapidae, Natricidae, Viperidae, Cheloniidae and Dermochelyidae (Table 2). The status of a species in Nayarit may differ (i.e. be worse or better) from the IUCN, SEMARNAT and EVS assessments. Thus, assessments at the State level are needed to fully understand the conservation or management needs for the Nayarit herpetofauna.

Table 4. Number of amphibian and reptile species in each physiographic province of Nayarit.

	Pacific Lowlands	Sierra Madre Occidental	Trans-Mexican Volcanic Belt	Sierra Madre del Sur	Nayarit Islands
Amphibians	19	25	25	23	4
Reptiles	43	70	71	54	27
TOTAL	62	95	96	77	31

Table 5. Number of amphibian and reptile species in each physiographic province of Nayarit listed and protected in the IUCN Red List or SEMARNAT list or with high EVS. Numbers in parenthesis represent the total number of species evaluated in each list. In some cases, the total numbers for each list differ because the IUCN Red List and EVS assessments have not yet been reported for all species, the only total equal to that of the species inhabiting each ecoregion is that of the SEMARNAT list.

	IUCN	SEMARNAT	EVS
Amphibians			
Pacific Lowlands	0 (16)	0 (19)	2 (18)
Sierra Madre Occidental	0 (24)	1 (25)	4 (24)
Trans-Mexican Volcanic Belt	1 (24)	0 (25)	5 (24)
Sierra Madre del Sur	0 (21)	0 (23)	3 (23)
Nayarit Islands	0 (4)	0 (4)	1 (4)
Reptiles			
Pacific Lowlands	6 (38)	8 (43)	9 (35)
Sierra Madre Occidental	2 (62)	8 (70)	25 (68)
Trans-Mexican Volcanic Belt	3 (59)	9 (71)	24 (69)
Sierra Madre del Sur	1 (45)	9 (54)	16 (53)
Nayarit Islands	5 (23)	6 (27)	5 (21)

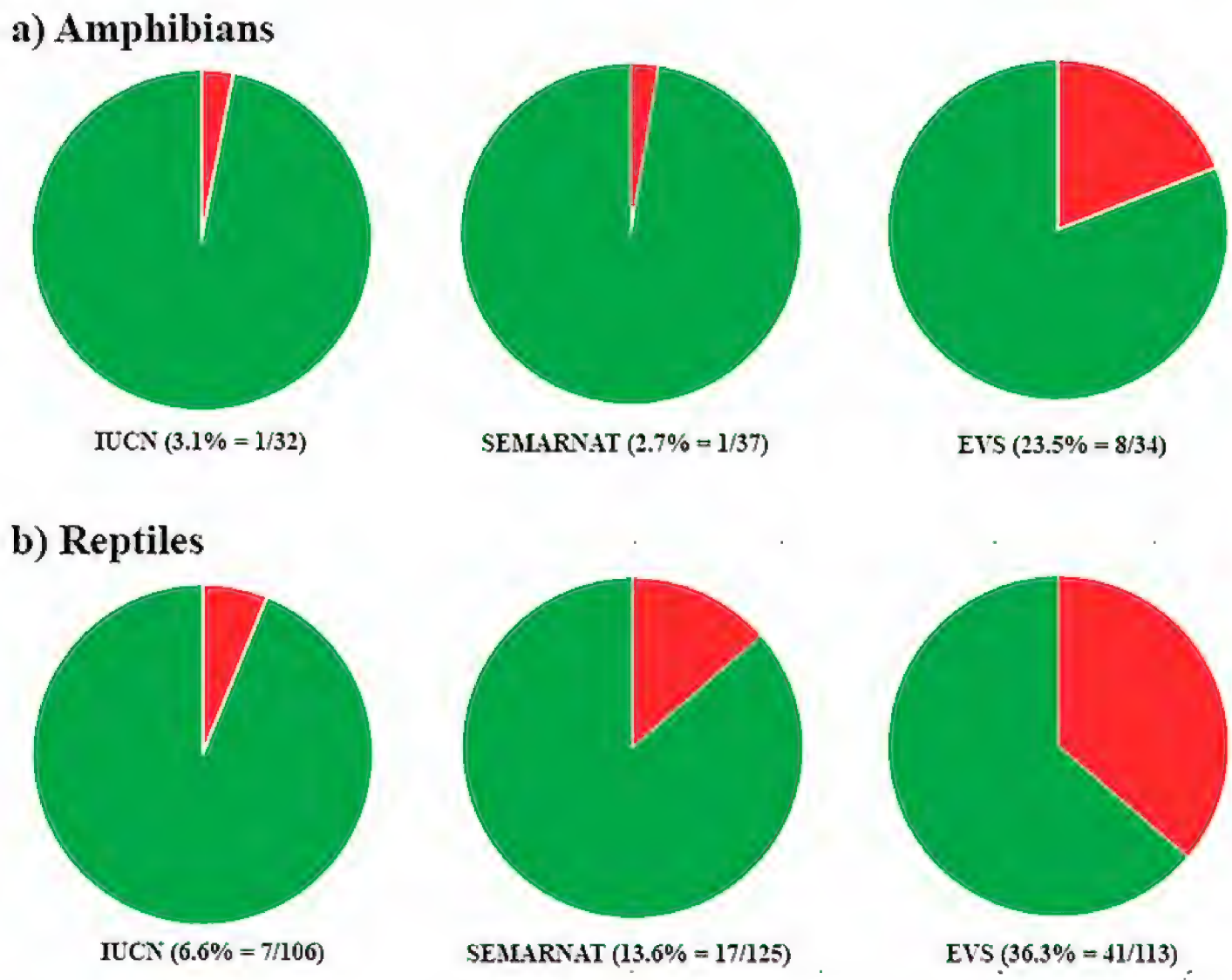

Figure 6. Proportion of **A.** Amphibians and **B.** Reptiles listed in protected categories on the IUCN Red List, SEMARNAT and high EVS for Nayarit. Green is the proportion in Data Deficient and Least Concern (IUCN); Not Listed and Subject to Special Protection (we regarded the category of Subject to Special Protection in SEMARNAT equivalent to Least Concern in IUCN) (SEMARNAT); or low or medium EVS. Red is percentage in protected categories or high EVS. N is the number of species assessed.

Comparison with neighbouring States

Overall, Nayarit shares the most herpetofaunal species with Jalisco, with 88.9% overlap (Table 6). Nayarit shares the most amphibian species with Jalisco (89.2%). Seven families, including Craugastoridae, Eleutherodactylidae, Hylidae, Leptodactylidae, Phyllomedusidae, Ambystomatidae and Plethodontidae, show complete overlap between Nayarit and Jalisco. Only four species of amphibians that inhabit Nayarit do not occur in Jalisco, two of them (*Anaxyrus kelloggi* and *Gastrophryne mazatlanensis*) reach their southernmost distribution in Nayarit, another (*Scaphiopus couchii*) reaches the southernmost distribution on the Mexican Pacific Coast extending its range eastwards to Hidalgo and Veracruz, the fourth (*Rana cora*) is a recently-described species that almost certainly occurs in Jalisco, but has not been reported there yet. The similarity between the amphibian composition of Nayarit and Sinaloa is also high (86.5%), showing complete overlap in almost the same families completely shared between Nayarit and Jalisco, with some slight differences. Sinaloa shows complete overlap with Nayarit in Bufonidae, Craugastoridae, Hylidae, Leptodactylidae, Microhylidae, Phyllomedusidae and Ambystomatidae. Only five species of amphibians that inhabit Nayarit do not occur in Sinaloa: *Eleutherodactylus modestus* is at its northernmost distribution in Nayarit; *Rana megapoda*, *R. psilonota* and *Isthmura belli* are at their north-westernmost distribution in Nayarit; and *Spea multiplicata* extends to western Mexico in the Sierra Madre Occidental and Trans-Mexican Volcanic Belt of Nayarit and Pacific Lowlands of Jalisco. The neighbouring States that share the lowest percentage of amphibian species with Nayarit are Durango (48.6%) and Zacatecas (37.8%). The high similarity in amphibian composition between Nayarit and Jalisco and Sinaloa, but not with Durango and Zacatecas, is due to the dominance of amphibian species related to the region of the Pacific Lowlands, which are shared between these three States with wide Pacific coasts and the absence of these coasts in Durango and Zacatecas. Durango is mostly a mountainous State dominated by the Sierra Madre Occidental and the Chihuahuan Desert (Lemos-Espinal et al. 2019), whereas Zacatecas is also a mountainous State dominated by the Sierra Madre Occidental, Sierra Madre Oriental and the Chihuahuan Desert.

The number of reptile species shared between Nayarit and Jalisco is large, with 88.8% overlap. Sixteen of the 24 families of reptiles present in Nayarit show a complete overlap with Jalisco and 111 of the species that inhabit Nayarit are shared with Jalisco. Ten of the 14 species of reptiles that inhabit Nayarit, but have not been recorded in Jalisco, show their southernmost distribution in Nayarit (*Holbrookia elegans*, *Urosaurus ornatus*, *Plestiodon parviauriculatus*, *Gyalopion quadrangulare*, *Rhinocheilus lecontei*, *Tantilla yaquia*, *Leptodeira polysticta*, *Thamnophis nigronuchalis*, *Crotalus willardi* and *Kinosternon cora*), two more are endemic to Nayarit (*Phyllodactylus cleofasensis* and *Thamnophis rossmani*)

Table 6. Summary of the numbers of species shared between Nayarit and neighbouring Mexican States (not including introduced species). The percentage of Nayarit species shared by a neighbouring State are given in parentheses. Total refers to the total number of species found in Nayarit and four neighbouring States (i.e. regional species pool) and the number in parentheses in this column is the percentage of the regional species pool found in Nayarit. -- indicates either Nayarit or the neighbouring State has no species in the taxonomic group or none of that specific taxon is shared between the States, thus no value for shared species is provided.

	Nayarit	Jalisco	Sinaloa	Durango	Zacatecas	Total
AMPHIBIA	37	33 (89.2)	32 (86.5)	18 (48.6)	14 (37.8)	75 (49.3)
ORDER ANURA	35	31 (88.6)	31 (88.6)	17 (48.6)	12 (34.3)	70 (50.0)
Bufonidae	5	4 (80.0)	5 (100)	4 (80.0)	2 (40.0)	14 (35.7)
Craugastoridae	5	5 (100)	5 (100)	3 (60.0)	2 (40.0)	7 (71.4)
Eleutherodactylidae	4	4 (100)	3 (75.0)	1 (25.0)	–	14 (28.6)
Hylidae	9	9 (100)	9 (100)	4 (44.4)	3 (33.3)	13 (69.2)
Leptodactylidae	1	1 (100)	1 (100)	–	–	2 (50.0)
Microhylidae	3	2 (66.7)	3 (100)	–	1 (33.3)	4 (75.0)
Phyllomedusidae	1	1 (100)	1(100)	1 (100)	–	1 (100)
Ranidae	5	4 (80.0)	3 (60.0)	2 (40.0)	2 (40.0)	13 (38.5)
Scaphiopodidae	2	1 (50.0)	1 (50.0)	2 (100)	2 (100)	2 (100)
ORDER CAUDATA	2	2 (100)	1 (50.0)	1 (50.0)	2 (100)	5 (20.0)
Ambystomatidae	1	1 (100)	1 (100)	1 (100)	1 (100)	4 (25.0)
Plethodontidae	1	1 (100)	–	–	1 (100)	1 (100)
ORDER GYMNOPHIONA	–	–	–	–	–	1 (0)
Caecilidae	–	–	–	–	–	1 (0)
REPTILIA	125	111 (88.8)	86 (68.8)	61 (48.8)	57 (45.6)	261 (47.9)
CROCODYLIA	1	1 (100)	1 (100)	–	–	1 (100)
Crocodylidae	1	1 (100)	1 (100)	–	–	1 (100)
SQUAMATA	113	100 (88.5)	75 (66.4)	59 (52.2)	55 (48.7)	239 (47.3)
LACERTILIA	44	39 (88.6)	26 (59.1)	24 (54.5)	18 (40.9)	104 (42.3)
Anguidae	3	3 (100)	2 (66.7)	1 (33.3)	3 (100)	5 (60.0)
Corytophanidae	1	1 (100)	–	–	–	1 (100)
Crotaphytidae	–	–	–	–	–	2 (0)
Dactyloidae	1	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)
Eublepharidae	1	1 (100)	–	–	–	4 (25.0)
Helodermatidae	1	1 (100)	1 (100)	1 (100)	1 (100)	3 (33.3)
Iguanidae	2	2 (100)	2 (100)	1 (50.0)	1 (50.0)	5 (40.0)
Phrynosomatidae	22	20 (90.9)	12 (54.5)	16 (72.7)	9 (40.9)	52 (42.3)
Phyllodactylidae	3	1 (33.3)	2 (66.7)	1 (33.3)	–	6 (50.0)
Scincidae	6	5 (83.3)	4 (66.7)	2 (33.3)	2 (33.3)	13 (46.2)
Teiidae	4	4 (100)	2 (50.0)	1 (25.0)	1 (25.0)	12 (33.3)
Xantusidae	–	–	–	–	–	3 (0)
SERPENTES	69	61 (88.4)	49 (71.0)	35 (50.7)	37 (53.6)	135 (51.1)
Boidae	1	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)
Colubridae	28	24 (85.7)	26 (92.9)	17 (60.7)	18 (64.3)	57 (49.1)
Dipsadidae	17	16 (94.1)	12 (70.6)	4 (23.5)	5 (29.4)	33 (51.5)
Elapidae	4	4 (100)	3 (75.0)	–	1 (25.0)	7 (57.1)
Leptotyphlopidae	1	1 (100)	–	–	1 (100)	5 (20.0)
Loxocemidae	1	1 (100)	–	–		1 (100)
Natricidae	9	7 (77.8)	3 (33.3)	8 (88.9)	6 (66.7)	16 (56.3)
Viperidae	8	7 (87.5)	4 (50.0)	5 (62.5)	5 (62.5)	15 (53.3)
TESTUDINES	11	10 (90.9)	10 (90.9)	2 (18.2)	2 (18.2)	21 (52.4)
Cheloniidae	3	3 (100)	3 (100)	–	–	4 (75.0)
Dermochelyidae	1	1 (100)	1 (100)	–	–	1 (100)
Emydidae	2	2 (100)	2 (100)	–	–	5 (40.0)
Geoemydidae	1	1 (100)	1 (100)	–	–	2 (50.0)
Kinosternidae	4	3 (75.0)	3 (75.0)	2 (50.0)	2 (50.0)	7 (57.1)
Testudinidae	–	–	–	–	–	2 (0)
TOTAL	162	144 (88.9)	118 (72.8)	79 (48.8)	71 (43.8)	336 (48.5)

and the other two have a discrete distribution that includes Nayarit, but not Jalisco (*Plestiodon* aff. *brevirostris* and *Salvadora grahamiae*). Nayarit shares a smaller, but still high percentage of reptile species with Sinaloa, with 68.8% overlap. Nine of the 24 families of reptiles present in Nayarit show a complete overlap with Sinaloa and 86 of the species that inhabit Nayarit are shared with Sinaloa. Twenty-three of the 39 species of reptiles that inhabit Nayarit, but have not been recorded in Sinaloa, show their northernmost distribution in Nayarit or Jalisco (*Barisia imbricata*, *Basiliscus vittatus*, *Coleonyx elegans*, *Sceloporus asper*, *S. dugesii*, *S. heterolepis*,

S. horridus, *S. huichol*, *S. melanorhinus*, *S. scalaris*, *S. unicanthalis*, *Plestiodon* aff. *brevirostris*, *Aspidoscelis lineattissimus*, *Holcosus sinister*, *Salvadora mexicana*, *Tantilla ceboruca*, *Hypsiglena affinis*, *Manolepis putnami*, *Rhadinaea taeniata*, *Sibon nebulatus*, *Micrurus proximans*, *Loxocemus bicolor* and *Kinosternon vogti*). Six more species show a discrete distribution that does not include Sinaloa (*Rena humilis*, *Thamnophis eques*, *T. errans*, *T. melanogaster*, *T. pulchrilatus* and *Salvadora grahamiae*). Another eight species are found in the Sierra Madre Occidental and/or Trans-Mexican Volcanic Belt (*Phrynosoma orbiculare*, *Sceloporus grammicus*, *Plestiodon lynxe*, *Thamnophis nigronuchalis*, *Crotalus armstrongi*, *C. campbelli*, *C. pricei* and *C. willardi*). The last two species not shared with Sinaloa are endemic to Nayarit (*Phyllodactylus cleofasensis* and *Thamnophis rossmani*). Nayarit shares 61 species of reptiles with Durango, representing a 48.8% overlap. This relatively low overlap compared to Jalisco and Sinaloa can be explained by the fact that Durango is dominated by species from the Sierra Madre Occidental and the Chihuahuan Desert, while the other three States (Nayarit, Jalisco and Sinaloa) are dominated by species from the Pacific Coast. Nayarit has a coastline of 307 km, Jalisco 351 km and Sinaloa 622 km. The lowest number of shared species between Nayarit and a neighbouring State is represented by Zacatecas with only 57 species shared with Nayarit, representing 45.6% overlap. Just as Durango, Zacatecas is dominated by species from the Sierra Madre Occidental and the Chihuahuan Desert, which may explain this low overlap with Nayarit.

The relationship between the neighbouring States of Nayarit shows that Nayarit is a transition State between species with Nearctic and Neotropical affinities; most of the species present in Nayarit, but absent in Sinaloa, show their northernmost distribution in Nayarit, contrary to most of the species present in Nayarit, but absent in Jalisco show their southernmost distribution in Nayarit. In addition, Nayarit is also a State that contains species from the Pacific Coast as well as the mountains of the Sierra Madre Occidental, Trans-Mexican Volcanic Belt and Sierra Madre del Sur.

Conclusions

One of the main take-home messages of our update of the list of the herpetofaunal species of Nayarit is that our understanding of the full complement of species is not complete, especially the reptiles. This is evidenced by the rapid accumulation of species in Nayarit in the past decade (see Fig. 5). In addition, our updated list has increased the number of country endemic species found in Nayarit. It seems likely, as herpetofaunal surveys and systematic studies continue, both in Nayarit and in other Mexican States, that the richness of amphibians and reptiles will increase.

Acknowledgements

We thank the logistic support provided by all the people of each locality visited in Nayarit. We are grateful to Alejandra Núñez Merchand from the National Commission for the Understanding and Use of Biodiversity (CONABIO) for kindly creating and providing the municipality, topographic, physiographic, climate and vegetation maps used in this publication and for generating the State border lengths of Nayarit's neighbouring States, to Isabel Cruz, also from CONABIO, for providing the satellite images of Nayarit and to Jesús Sigala-Rodríguez for allowing us access to an unpublished list of amphibians and reptiles of Zacatecas. Support for this study was provided by the Turtle Conservation Fund-TCF (096) and Mohamed bin Zayed Species Conservation Fund MZSC (220529355), through Project Ecological Observations of Cora Mud Turtle (*Kinosternon cora*) in Nayarit and Sinaloa, Mexico to JLB; TecNM projects 5293.19-P and 14548.22-PD, Subsecretaría de Educación Superior through the Dirección General de Educación Superior Universitaria e Intercultural and Dirección de Superación Académica granted the funds for the group Ecología, Distribución y Conservación de Fauna Silvestre IDCA 27963, Clave ITESZACA-CA-4, 2020–2021; and internal grants from the ITS Zacapoaxtla PI-LB to GAWP; and through the generous support provided by the Dirección General de Asuntos del Personal Académico – Programa de Apoyos para la Superación del Personal Académico de la UNAM (DGAPA-PASPA) through the scholarship assigned to JLE for his sabbatical year at the University of Colorado, Boulder and by the Dirección General de Asuntos del Personal Académico – Programa de Apoyo a Proyectos de Investigación e Innovación Tecnológicas (DGAPA-PAPIIT) through the project IN202021. We thank one anonymous reviewer and the subject editor (B. Rojas) for helpful comments that improved the manuscript.

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